MEPN NODE DESIGN SPECIFICATIONS

The *Missouri Emergency Packet Network (MEPN) Project Plan,* approved May 2, 2003, contained the minimum requirements for site coordination and node configuration. This document expands on the minimal requirements information by providing a detailed list of components and functions required for each MEPN node. A brief, written, statement is included for many of the listed items to explain, in advance, the reasoning behind the selection.

1. COORDINATION – All MEPN nodes will be coordinated in three key areas; node names, frequency assignment and site selection. Additional coordination will be needed if more than one node is designated to serve the same geographic area.

    1.1. NODE NAMES – All MEPN nodes will follow the naming guidelines contained in the *MEPN Node Naming Convention* document dated June 27, 2003.

    1.2. FREQUENCY ASSIGNMENT – All MEPN 6-mtr nodes will use the coordinated frequency of 50.680 MHz. The co-located 2-mtr node will use 145.030, 145.050, 145.070 or 145.090 MHz, depending on local emergency packet practices. Absent of any existing local preferences, MEPN recommends using 145.070 MHz to broaden the consistency across the state.

    1.3. SITE SELECTION – At least one site will be selected from within each highway patrol troop district. Site approval will be initially made by the MEPN Project Coordinator and, in the future, by the MEPN Project Administrator. Site selection will be based on, but not limited to, the criteria listed below. Remember, the purpose of MEPN is to provide reliable communications, via Amateur Radio, from all parts of the state to the SEMA offices in Jefferson City.

        1.3.1. Path – A solid path from the proposed node to the Jefferson City node will be given the highest priority. Solid paths to adjacent nodes may be considered as an alternate to a direct connection to Jefferson City.

        1.3.2. Backup Power – A source of power, independent of the normal AC mains, is required. A battery bank, supplemented by an emergency generator is ideal, but may not be available to all tenants on a tower. Operating two packet stations, under emergency conditions, will quickly deplete a single battery.

        1.3.3. Antenna Height – While the path from node to node is the most important consideration, the height of the antennas is also important. Generally, the higher the 2-mtr antenna, the easier it will be for low-powered, portable stations, operating from shelters and field sites, to send and receive data reliably. High mounted 6-mtr antennas will allow more favorable connections to adjacent nodes that may not be selected at the time when a node is approved.

        1.3.4. Site Access – Direct, 24 hour, site access by hams would be ideal, but not often possible. Node approvals will consider working agreements between the site owner and the MEPN node sponsor.

2. NODE CONFIGURATION – To achieve the goal of providing reliable communications from all parts of the state to Jefferson City, MEPN nodes must operate 24/7 in all kinds of conditions. The commercial two-way radio business and successful Amateur repeater operators have developed strategies that reduce downtime and weather related outages. MEPN nodes will incorporate these strategies, as appropriate, to enhance system availability.

2.1. Six Meter – The 6-mtr frequency is the easiest, and at the same time, the most difficult node to place in service. Easiest from the standpoint of available rigs and little or no interference to the RX or from the TX. Difficult from the standpoint of antennas, wattmeter slugs and tower space. Considering the operating experience of the highway patrol on a nearby frequency and the limited number of MEPN nodes, each node should have an ERP rating of 200 watts or more. This can be achieved through a combination of transmitter power and antenna configuration.

2.1.1. Transceiver – Used, commercial transceivers are economically available in both 50 and 100 watt configurations. Many of these rigs are easily converted to Amateur frequencies. While commercial rigs are preferred (known track record), radios and amplifiers, designed for Amateur service, or homebrew rigs, will be considered. Again, reliability is the most important consideration.

Examples of acceptable commercial radios are the GE Delta, GE Ranger or the Motorola Mitrek. Modification information on these radios can be found on the www.packetradio.com Web site. Additional technical information is available from the project Technical Director.

2.1.2. Antenna – Most Amateurs have little or no experience with antennas for six meters. The common Ringo Ranger and homemade J-pole may work well for the limited duty of a private station, but neither is designed to withstand the rigors of the elements when mounted high above the ground and stacking, to achieve gain, is not well documented or tested. Commercial antennas are not generally marketed to operate above 50 MHz.

However, some commercial antennas can easily be modified to operate and provide gain at the 50.680 MHz MEPN frequency. One such product is the Decibel Products DB212 series. These folded dipole antennas are extremely rugged and can be stacked to provide up to 12 dB of gain (not likely in MEPN configurations).

2.1.3. Feedline – The feedline losses of good RG8 type coax at 50 MHz is not significant. However, RG8 is not rugged enough to withstand the rigors of tower maintenance by professional climbers and riggers. At a minimum, the feedline should be ½" jacketed Heliax for good mechanical protection and long life. Some tower managers require 7/8" jacketed Heliax to minimize feedline damage from falling ice. Inside the tower building, ½" jacketed Heliax or ½" Superflex, for ease of bending, is sufficient to keep RF interference to a minimum.

2.1.4. Lightning Protection – For the purposes of this specification, it is assumed that the tower already exists and that the proper grounding and lightning protection is in place. There are three lightning protection issues when adding a transmitter and antenna on an existing tower.

2.1.4.1. Equipment Grounding – The transceiver and power source must be securely grounded to the tower building grounding grid. This is necessary to assure that all components rise to the same voltage level during a lightning strike. The minimum size copper bonding conductor should be a #6 AWG.

2.1.4.2. Feedline Shield – The grounding connection to the outer shield of the Heliax should be bonded to the tower grounding plate outside the building. The connection point should be just above the point where the feedline bends from vertical to horizontal to enter the building. This provides the straightest path to ground for the lightning strike voltage and directs it away from the equipment. Some site managers require the same grounding connection at the top of the feedline as it leaves the antenna.

2.1.4.3. Lightning Arrestor – Lightning arrestors are designed to limit the high voltage spike and to reduce the energy "let through" to levels that do not damage the attached equipment. Selecting an arrestor near the operating frequency and transmitter power level will result in a lower clamping voltage and lower total energy let through. As an example, arrestors from the same company have a total energy let through of between 313 and 250,000uJ at VHF. For 6-mtrs, a PolyPhaser IS-NEMP-C1 or IS-50NX-C1, depending on mounting requirements, is recommended.

2.1.5. Power Supply – A robust power supply is needed to provide continuous operation during an emergency. Each packet system (2-mtr & 6-mtr) includes a 100 watt transmitter, TNC, receiver and required controls, and draws 21 amperes at 12 VDC. A separate power supply can be used for each system, or a 50 amp supply can power both systems. Astron makes 50 amp supplies that have operated in repeater service for many years without failure.

2.1.6. Power Distribution – Routing power to each component in the system may require a distribution panel or rack. Input lugs from the power supply should be capable of accepting a #8 AWG wire (45 amps). The output requires fuses for three circuits with lugs for a #8 AWG to the transceiver and #16 AWG to both the TNC and control head. If the same power supply is feeding both sides of the node, it is impossible to properly terminate six lugs directly to the power supply output studs.

2.1.7. TNC – The TNC should be TAPR TNC2 compatible. TNC's running this firmware are easily converted to the software required for proper node operation. The recommended TNC is the MFJ-1270C.

2.1.8. Firmware – The MEPN system will utilize "TheNET X-1J4" firmware in all nodes. The 2-mtr and 6-mtr TNC's will be interconnected, via their respective RS-232 ports, to allow for multi-frequency operation.

2.1.9. X-1J4 Parameters – A separate document will contain all of the X-1J4 software parameters as they are developed, tested and adjusted for proper MEPN node operation.

2.2. Two Meter – The co-located 2-mtr side of the node is probably more difficult to design. Many towers available to Amateurs may already have a 2-mtr repeater installed on them. A second 2-mtr antenna may have to be installed in a lower, less desirable, location on the tower. Then there is the potential issue of one 2-mtr system desensing the other. A combiner, similar to a duplexer on a repeater, can allow multiple transmitters and receivers to use a single antenna, in the same band. While these devices are expensive, their cost is in line with the purchase and installation of a second antenna, feedline, lightning arrestor, etc.

2.2.1. Transceiver - Used, commercial transceivers are economically available in both 50 and 100 watt configurations. Many of these rigs are easily converted to Amateur frequencies. While commercial rigs are preferred (known track record), radios and amplifiers, designed for Amateur service, or homebrew rigs, will be considered. Again, reliability is the most important consideration.

Examples of acceptable commercial radios are the GE Delta, GE Ranger or the Motorola Mitrek. Modification information on these radios can be found on the www.packetradio.com Web site. Additional technical information is available from the project Technical Director.

2.2.2. Antenna –The Cushcraft Ringo Ranger, the Hustler G6-144 and homemade J-poles may work well for the limited duty of a private station, but none are designed to withstand the rigors of the elements when mounted in the clear, high on a tower. Commercial, base station antennas from Celwave or Decibel Products will provide more reliable operation over the long haul.

2.2.3. Feedline – The feedline losses of good RG8 type coax at 150 MHz is significant. The minimum acceptable feedline is ½" jacketed Heliax. However, for long runs and to provide additional mechanical protection, it is recommended that 7/8" jacketed Heliax be used. Inside the tower building, ½" jacketed Heliax or ½" Superflex, for ease of bending, is sufficient to keep RF interference to a minimum.

2.2.4. Lightning Arrestor – Lightning arrestors are designed to limit the high voltage spike and to reduce the energy "let through" to levels that do not damage the attached equipment. Selecting an arrestor near the operating frequency and transmitter power level will result in a lower clamping voltage and lower total energy let through. As an example, arrestors from the same company have a total energy let through of between 313 and 250,000uJ at VHF. For 2-mtrs, a PolyPhaser IS-NEMP-C1, or IS-50NX-C1, depending on mounting requirements, is recommended.

2.2.5. Power Supply – A robust power supply is needed to provide continuous operation during an emergency. Each packet system (2-mtr & 6-mtr) includes a 100 watt transmitter, TNC, receiver and required controls, and draws 21 amperes at 12 VDC. A separate power supply can be used for each system, or a 50 amp supply can power both systems. Astron makes 50 amp supplies that have operated in repeater service for many years without failure.

2.2.6. Power Distribution – Routing power to each component in the system may require a distribution panel or rack. Input lugs from the power supply should be capable of accepting a #8 AWG wire (45 amps). The output requires fuses for three circuits with lugs for a #8 AWG to the transceiver and #16 AWG to both the TNC and control head. If the same power supply is feeding both sides of the node, it is impossible to properly terminate six lugs directly to the power supply output studs.

2.2.7. TNC – The TNC should be TAPR TNC2 compatible. TNC's running this firmware are easily converted to the software required for proper node operation. The recommended TNC is the MFJ-1270C.

2.2.8. Firmware – The MEPN system will utilize "TheNET X-1J4" firmware in all nodes. The 2-mtr and 6-mtr TNC's will be interconnected, via their respective RS-232 ports, to allow for multi-frequency operation.

2.2.9. X-1J4 Parameters – A separate document will contain all of the X-1J4 software parameters as they are developed, tested and adjusted for proper MEPN node operation.

MEPN ACTIVITIES REPORT

Roger H Volk, KØGOB

July 2003

ADMINISTRATIVE – Issued the *MEPN Node Design Specifications* document, which provides a consistent design basis for each node, using proven components and techniques.

Met with a potential sponsor for the Jefferson City node and provided them with information for their consideration.

Met with SEMA personnel to review proposed equipment arrangement and possible site locations. SEMA has offered a site, remote from their offices, for use by the Jefferson City node.

Picked up eight GE Rangers, already converted to the 6-mtr MEPN node frequency from SEMA. Included in the package were 10 control heads (no mounting brackets), 10 control head power and control cable sets, two GE mics and nine control and power cable sets.

Designed and built the power distribution rack for the St. Louis node.

Handed out flyers at the Washington, MO hamfest.

NODES – This section will continue to grow as node sponsors are selected.

> ST. LOUIS – Sponsor: Monsanto Amateur Radio Association, Inc. Contact: George, wb0iis@arrl.net. Proposed configuration: 100 watt GE Delta's on both 2 & 6 mtrs; MFJ 1270C's; Decibel Products DB212-2 antenna for 6 and a TX/RX T-Pass Combiner to allow the 2 mtr packet node to co-exist with existing 2 mtr repeater. Status: Antenna and feedline installed at 190' for 6 mtrs, Combiner installed and operational on 2 mtr repeater, rigs and TNC's mounted on 5 1/4" rack shelves, firmware on order.
>
> JEFFERSON CITY – Possible sponsor considering volunteering to support the node.

NEAR TERM PLANS

1. Complete the path loss study from the SEMA offered site in Jeff City, to St. Louis.
2. Continue to assist in getting the St. Louis node operational, now targeted in August.
3. Continue dialogue with Amateurs in KC to identify potential node sponsor.

MEPN ACTIVITIES REPORT

Roger H Volk, KØGOB

November 2003

GENERAL – In spite of most participants taking some time off for the Thanksgiving Day holiday, many "behind the scenes" activities were addressed during the month. The three major items were the tower situation in Jefferson City, a possible new node site in the central part of the state and components for the Jeff City site.

As noted last month, the tower situation in Jeff City is "fluid". Contacts were made with several tower owners, but none resulted in an on-going dialogue about the possibility of obtaining the space required for an antenna system at 50 MHz. The focus has shifted back to rearranging antennas on the SEMA tower to accommodate the MEPN system. The analysis of the latest structural study on the tower is in progress.

Meanwhile, antennas, Heliax, power supplies, cabinets and the like have been placed on order for the Jeff City node. Some of the items have started to arrive. These purchases were made possible through generous donations from individual Amateurs, the UHF ARA, and St. Louis area businesses.

A potential new site, between Jeff City and Springfield, has been identified and is being evaluated.

The MEPN project team has been asked to present a paper at the 2004 Crisis Communications Conference, hosted by SEMA, on February 14, 2004. In addition to the paper, the team plans to exhibit a complete working node.

NODES – This section will continue to grow as node sponsors are selected.

ST. LOUIS – Sponsor: Monsanto Amateur Radio Association, Inc. Contact: George, wb0iis@arrl.net. Proposed configuration: 100 watt GE Delta's on both 2 & 6 mtrs; MFJ 1270C's; Decibel Products DB212-2 antenna, modified for 6 and a TX/RX T-Pass Combiner to allow the 2 mtr packet node to co-exist with existing 2 mtr repeater. Status: Antenna and feedline installed at 190' for 6 mtrs, Combiner installed and operational on 2 mtr repeater. Antenna mounted at 220'. Node rigs and TNC's mounted on 5 1/4" rack shelves. Six meter and 2-mtr stations now independently operational into dummy loads.

JEFFERSON CITY – Sponsor: UHF ARA, Inc. Contact: Roger, k0gob@arrl.net. Proposed configuration: 100 watt GE Delta's on both 2 & 6 mtrs; MFJ 1270C's" Decibel Products DB212-3-C antenna, modified for 6 and a PD220-2 antenna for 2-mtrs. Status: Design stage, material collection.

SEDALIA – Contact with possible sponsor has been made and technical data is being exchanged to determine if a suitable site is available.

INDEPENDENCE – Contact with possible sponsor has been made and site technical data has been received and is now being reviewed.

NEAR TERM PLANS

1. Complete design of Jeff City node and begin procurement of components.
2. Complete the path loss study from the Jefferson City site to Sedalia.
3. Continue to assist in getting the St. Louis node operational.
4. Continue dialogue with interested Amateurs to identify potential node sponsors.

MEPN ACTIVITIES REPORT

Roger H Volk, KØGOB

December 2003

SUCCESS – The St. Louis MEPN node now operates in full X1J4 mode! George, WBØIIS, the MEPN Technical Director, spent his holiday vacation putting the finishing touches on the conversion. When foil traces need to be cut, and holes need to be drilled through the case of commercial equipment, you don't get a second chance to do it right the first time. After analyzing what was needed, George investigated what had been done before (good old Web) and designed the required interface to be as trouble free as possible. Not only that, but no smoke escaped when the power was applied. The 2-mtr side is on the air from an attic mounted antenna and is 60 dB over S9 at my shack.

The configuration will now be moved from the test bench to a portable rack and taken around to various Amateur radio clubs and functions before placed in service. The final stop will be the 2004 Crisis Communications Conference, hosted by SEMA in February. Other scheduled demo stops are the January 10th QCWA Chapter 19 meeting and the MARA meeting on January 20th. Both organizations have extended an open invitation to non-members to see this demo. Other demos may be possible before the node is installed in its permanent, out-of-sight, location.

GENERAL – The analysis of the latest structural study on the SEMA tower is in progress.

The MEPN project team has been asked to present a paper at the 2004 Crisis Communications Conference, hosted by SEMA, on February 14, 2004. In addition to the paper, the team will exhibit the St. Louis equipment and 2 & 6 meter rigs, as a complete working node.

NODES – This section will continue to grow as node sponsors are selected.

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> JEFFERSON CITY – Sponsor: UHF ARA, Inc. Contact: Roger, k0gob@arrl.net. Proposed configuration: 100 watt GE Delta's on both 2 & 6 mtrs; MFJ 1270C's" Decibel Products DB212-3-C antenna, modified for 6 and a PD220-2 antenna for 2-mtrs. Status: Design stage.
>
> SEDALIA – Contact with possible sponsor has been made and technical data is being exchanged to determine if a suitable site is available.
>
> INDEPENDENCE – Contact with possible sponsor has been made and site technical data has been received and is now being reviewed.

NEAR TERM PLANS

1. Analyze SEMA tower to determine if it can support MEPN antennas.
2. Complete design of Jeff City node and begin procurement of components.
3. Complete the path loss study from the Jefferson City site to Sedalia.
4. Continue dialogue with interested Amateurs to identify potential node sponsors.

MEPN ACTIVITIES REPORT

Roger H Volk, KØGOB

January 2004

ROAD SHOW – The fully operational St. Louis MEPN node has been on a 1000 mile traveling road show during the month. The node, complete with laptops, rigs and TNC's for a 2-meter input station and a 6-meter remote output station (simulating SEMA's headquarters) has been well received throughout the state. The operating demos and handouts have encouraged several groups to come forward for node sponsorship consideration. As these sponsorships are in the very early stage of consideration, they are not reported in the Node Status list below.

Two individuals from the Illinois Emergency Management Agency (IRMA) stopped by the display. After seeing the demo and listening to an explanation of the system concept, they said that the same type of system was needed in IL and that they would be contacting the ARES organization in their state.

GENERAL – The analysis of the latest structural study on the SEMA tower is in progress as well as path losses from some of the newly interested sponsor locations.

TNC's, other than the MFJ 1270C's, are being reviewed to determine what to use on the 6-mtr side to achieve speeds greater than 1200 bps. This decision needs to be made before multiple nodes are installed across the state, making the upgrade more difficult.

While the 6-mtr antenna for the Jeff City site has been secured, an upgrade may be needed to provide the required gain. A complete DB212-6 may be required to provide the minimum 3 dB gain in a circular pattern, do to the width of the face on the self-support tower.

The MEPN project team has been asked to present a paper at the 2004 Crisis Communications Conference, hosted by SEMA, on February 14, 2004. In addition to the paper, the team will exhibit the St. Louis equipment and 2 & 6 meter rigs, as a complete working node.

NODES – This section will continue to grow as node sponsors are selected.

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> JEFFERSON CITY – Sponsor: UHF ARA, Inc. Contact: Roger, k0gob@arrl.net. Proposed configuration: 100 watt GE Delta's on both 2 & 6 mtrs; MFJ 1270C's" Decibel Products DB212-3-C antenna, modified for 6 and a PD220-2 antenna for 2-mtrs. Status: Design stage, one 350' roll of 7/8" Heliax, the PD220-2 antenna, the DB212-3 antenna and a number of smaller connectors, are now in hand.
>
> SEDALIA – Contact with possible sponsor has been made and technical data is being exchanged to determine if a suitable site is available.
>
> INDEPENDENCE – Contact with possible sponsor has been made and site technical data has been received and is now being reviewed.

MEPN ACTIVITIES REPORT

Roger H Volk, KØGOB

February 2004

FIRST NODE OPERATIONAL

You know we're excited when the first sentence in the monthly report is printed with a font larger than the report title. The St. Louis area MEPN node is on the air. You can access it on 145.070 MHz by connecting to MSTL. Typing 'INFO' will deliver a more detailed message about the system. If you have 6-mtr packet equipment, drop us a note and we will give you the codes to connect to it through the node from the local 2-mtr input.

SEMA CONFERENCE – The fully operational MEPN node drew lots of attention at the SEMA Crises Communications Conference in mid month. The demo, coupled with the paper presented by the ARRL SEC, Don Moore, KMØR; the MEPN Technical Director, George Schindler, WBØIIS; and this writer, resulted in a good deal of discussion and great promised support.

Last month's report indicated that Amateurs, working for the Illinois Emergency Management Agency (IEMA) stopped by the traveling road show at the Winterfest Hamfest. Based on their comments, the IEMA Communications Director attended the SEMA conference and left with a favorable impression of the MEPN concept.

GENERAL – Little visible progress is anticipated during March. Behind the scenes work will be on going in two important areas. 1) Tower/site path analysis, and 2) High speed TNC's on the 6-mtr side of the node.

Rigs and cables continue to be modified and power distribution racks are being built for future nodes.

With tax time and "home projects" that were delayed during the push to get the first node operational, all of the key, volunteer, participants will be spending less time on MEPN work during March.

NODES – This section will continue to grow as node sponsors are selected.

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